Nature Conservation 34: 1–8 (2019)
doi: 10.3897/natureconservation.34.35517
http://natureconservation.pensoft.net

EDITORIAL

A peer-reviewed open-access journal
Nature Conservation
Launched to accelerate biodiversity conservation

Editorial

Maria Grazia Mazzocchi[1], Lucilla Capotondi[2], Michele Freppaz[3,4], Antonella Lugliè[5], Alessandro Campanaro[6]

1 *Stazione Zoologica Anton Dohrn, Villa Comunale, 80121 Napoli, Italy* **2** *Institute of Marine Sciences (ISMAR), National Research Council, Via Gobetti 101, 40129 Bologna, Italy* **3** *Department of Agricultural, Forest and Food Sciences, University of Torino, Largo Paolo Braccini 2, 10095 Grugliasco (Torino), Italy* **4** *Research Center on Natural Risk in Mountain and Hilly Environments, NatRisk, University of Torino, Largo Paolo Braccini 2, 10095 Grugliasco (Torino), Italy* **5** *Department of Architecture, Design and Urban Planning, University of Sassari, Via Piandanna 4, 07100 Sassari, Italy* **6** *Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria – Centro di ricerca, Difesa e Certificazione (CREA – DC), Via di Lanciola 12/a, 50125 Cascine del Riccio (Firenze), Italy*

Corresponding author: *Maria Grazia Mazzocchi* (grazia.mazzocchi@szn.it)

Received 17 April 2019 | Accepted 17 April 2019 | Published 3 May 2019

http://zoobank.org/55D45437-9E2B-4F22-A2D1-9C7E070F750A

Citation: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (2019) Editorial. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 1–8. https://doi.org/10.3897/natureconservation.34.35517

The Long-Term time series of Ecological Research (LTER) allow us to follow the evolution of the ecosystems over decadal scales to understand the driving processes behind their temporal variability in relation to local and global stressors.

LTER-Italy (http://www.lteritalia.it) network includes terrestrial, freshwater, transitional and marine sites where ecological research is regularly carried out on decadal scale with the involvement of numerous universities, scientific and technical institutions, as well as local authorities. Since 2006, LTER-Italy is part of LTER-Europe (http://www.lter-europe.net) and LTER-International (https://www.ilter.network) networks. LTER-Italy consists of 79 research sites belonging to 25 different areas (parent sites) distributed throughout the Country and also including extra-national sites in the Ross Sea (Antarctica) and in the Himalayas (Nepal).

Copyright *Maria Grazia Mazzocchi et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Figure 1. Localisation of the LTER sites covered in this Special Issue. In the large panel, the Italian sites: terrestrial (brown), freshwater (light blue), transitional (green), marine (blue). In the inset: **A** Italy **B** Northern Europe **C** California (USA) **D** Ross Sea (Antarctica).

The present Special Issue entitled "*Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains*" is the first published collection of studies performed at LTER-Italy sites which address the diversity and dynamics of ecosystems in different domains in response to natural and anthropogenic forcing. Eighteen papers in the volume present research carried out at 2 Antarctic and 16 Italian sites, one of which includes a comparative analysis with other International LTER sites in Northern Europe and USA (Figure 1 and Table 1). Two additional cross-domain papers address methodological and conceptual themes: Zilioli et al. (2019) tackle data management practices and interoperability for the monitoring of the Essential Biodiversity Variables in LTER-Italy; Ribera d'Alcalà (2019) compares terrestrial and marine ecosystems, highlighting their similarities and specific features in response to perturbations and climate change.

The studies focus on terrestrial (7 papers) and aquatic (11) domains, the latter including marine (7), transitional (3) and freshwater (1) ecosystems. The research sites span over a wide altitudinal range, from the mesopelagic ocean (-800 m) to the high-elevation mountain (2.800 m) and reflect the large diversity of the Italian territory and landscapes. The papers cover a broad range of topics, from biodiversity to biogeochemical fluxes, over time scales up to three decades. The different environments, organisms and processes are analysed with the common goal to discern the main modes

Table 1. List of the LTER sites covered in the papers of this Special Issue, with their names, DEIMS.ID (https://deims.org/docs/deimsid.html) and references, in the same order as they appear in the Index.

LTER site name	DEIMS-ID	Special Issue reference papers
Appennino centrale: Gran Sasso d'Italia, Italy	https://deims.org/c0738b00-854c-418f-8d4f-69b03486e9fd	Petriccione and Bricca 2019
Val Masino LOM1, Italy	https://deims.org/68a5673c-9172-48cc-88e5-b9408b203309	Balestrini et al. 2019
Istituto Scientifico Angelo Mosso (MOSSO), Italy	https://deims.org/17210eba-d832-4759-89fa-9ff127cbdf6e	Freppaz et al. 2019
Gran Paradiso National Park, Italy	https://deims.org/e33c983a-19ad-4f40-a6fd-1210ee0b3a4b	Cerrato et al. 2019
IT25 – Val Mazia/ Matschertal, Italy	https://deims.org/11696de6-0ab9-4c94-a06b-7ce40f56c964	Steinwandter et al. 2019
Foce Trigno-Marina di Petacciato (Campobasso), Italy	https://deims.org/1835cda2-b56d-400a-b413-ab5c74086dc5	Marzialetti et al. 2019
Foce Saccione-Bonifica Ramitelli (Campobasso), Italy	https://deims.org/088fe3af-c5bb-4cc8-b479-fe1ea6d5be80	Marzialetti et al. 2019
Montagna di Torricchio, Italy	https://deims.org/6b62feb2-61bf-47e1-b97f-0e909c408db8	Chelli et al. 2019
Lago Bidighinzu, Italy	https://deims.org/3707cf71-7e04-41e3-8afc-518b293f6c07	Pulina et al. 2019
Laguna di Venezia, Italy	https://deims.org/f7d94927-17be-4d3d-9810-e3c9bc91829c	Sfriso et al. 2019
Mar Piccolo of Taranto, Italy	https://deims.org/ede24c6e-9cf2-4cf8-8bf7-36ba327403b4	Petrocelli et al. 2019
Sacca di Goro, Italy	https://deims.org/b7869194-b220-473a-b035-feeadfa21aba	Pitacco et al. 2019
Valli di Comacchio, Italy	https://deims.org/70e1bc05-a03d-40fc-993d-0c61e524b177	Pitacco et al. 2019
LTER Marechiara, Italy	https://deims.org/0b87459a-da3c-45af-a3e1-cb1508519411	Zingone et al. 2019
Santa Barbara Coastal LTER, United States of America	https://deims.org/dbd399ed-9c26-4621-b479-7ab505c8aa35	Kröncke et al. 2019
Archipelago Research Institute, Finland (Seili LTER)	https://deims.org/9d4222a2-c50f-4fac-8b1d-3b685072b34d	Kröncke et al. 2019
North Sea Benthos Observatory, Germany	https://deims.org/50946250-c0fa-41b0-a917-17d2a3992eee	Kröncke et al. 2019
Golfo di Olbia, Italy	https://deims.org/3178d0fb-0789-4992-9c51-1ddb50b7e871	Kröncke et al. 2019
LTER Observatory HAUSGARTEN, Germany	https://deims.org/f6d9ed12-6bc1-47fb-8e81-ef24e9579596	Kröncke et al. 2019
Golfo di Trieste, Italy	https://deims.org/96969205-cfdf-41d8-979f-ff881ea8dc8b	Cerino et al. 2019; Monti-Birkenmeier et al. 2019; Franzo et al. 2019
Mooring A: Southwestern Ross Sea, Ross Island, Antarctica	https://deims.org/86b6465c-b604-4efa-9145-0805f62216f4	Chiarini et al. 2019; Azzaro et al. 2019
Mooring B: North Central Ross Sea, Joides Basin, Antarctica	https://deims.org/1fb62b9c-4d5c-4f1f-8882-807032337de7	Azzaro et al. 2019

of temporal variability and to understand the causes of the observed modifications. The heterogeneity of the presented research activities mirrors the variety of ecological issues that need to be addressed to achieve proper environmental conservation and management practices.

For the terrestrial environment, papers in this Special Issue investigate the effects of climate variability and habitat use on the biological and biogeochemical components of ecosystems from the sea-level coasts to the peaks of the Alps in a variety of habitat types, such as forests, grasslands and dunes. Amongst the "sentinels" of environmental changes, the readers will find the high-elevation plants reported by Petriccione and Bricca (2019), which varied significantly in the species coverage, and the butterflies whose variations in species distribution and community composition was investigated by Cerrato et al. (2019). Carbon and nitrogen cycles are influenced by climatic drivers, as well as by the atmospheric inputs and the study of these elements in the soil and soil solution provides important data on the ecosystem functioning, as outlined by Freppaz et al. (2019) in the alpine tundra and by Balestrini et al. (2019) in a montane forest. Alien species invasions are another effect of habitat and climate alteration that can be monitored and modelled in the LTER network. An example is the study of Marzialetti et al. (2019), in which the authors provide a first exploratory analysis of the environmental characteristics promoting the rapid growth and development of *Acacia saligna* in Italian dune ecosystems and identify coastal areas as the main habitats that are affected by the invasive process. From a methodological point of view, Chelli et al. (2019) designed a monitoring system for the study of species richness and assemblage patterns over time, based on a probabilistic sampling scheme. LTER sites are also important for their contribution to biodiversity and biogeography knowledge, as demonstrated by the finding in South Tyrol of *Opetiopalpus sabulosus*, a beetle inhabiting steppe-like grasslands, which represents the first record of the species for the European Alps and Central Europe (Steinwandter et al. 2019).

Multiannual research in aquatic domains has revealed a remarkable interannual variability in different ecosystems, from temperate to polar latitudes. Different kinds of natural factors seem to have affected microbial processes (Franzo et al. 2019) and phytoplankton patterns (Cerino et al. 2019) in the north Adriatic Sea, as well as vertical particle fluxes (Chiarini et al. 2019) and microbial metabolism (Azzaro et al. 2019) in the Ross Sea (Antarctica). Conversely, decreased anthropogenic forcing was found to be responsible for the significant changes of phytoplankton in a eutrophic reservoir (Pulina et al. 2019) and of benthic macrophytes in a coastal embayment (Petrocelli et al. 2019). The long-term analysis of various ecosystem components has also proved to be useful to identify key variables that may allow environmental dynamics to be followed in view of possible future limitations of sampling or analytical efforts. This is the case of tintinnids for marine microzooplankton (Monti-Birkenmeier et al. 2019), taxonomic surrogates for benthic assemblages in transitional ecosystems (Pitacco et al. 2019) and nutrients, such as nitrites and reactive phosphorus for the trophic status of the Venice Lagoon (Sfriso et al. 2019). The value of LTER investigations, generally conducted at a single site, is further enhanced by expanding the spatial scale of the

observations in a comparative effort, which is especially useful for the prediction of future changes in marine systems in response to climate variability and ocean warming (Kröncke et al. 2019). Finally, besides the record of fluctuations and trends, long-term ecological research plays an invaluable role as an inspiration for other research, while the LTER sites can also be used as natural laboratories to test hypotheses and answer specific scientific questions. They can therefore have a primary role in the development of the knowledge of ecosystems much beyond the local scale (Zingone et al. 2019).

The content of this volume underlines and confirms how observations and analyses of ecological variables and processes at multiple scales are keys to understand important ecological relationships. Similar ecosystems can respond differently to identical changes in system drivers, depending on their inherent ecological structure and functioning, their history and spatial location within the territory and connections with adjacent ecosystems. The insights gained by this kind of research contribute to multiple aspects: from the formulation of general laws of ecology to the development of policies to face the Grand Challenges under Global Change at local, regional and planetary levels.

Before leaving the readers to enter the core of this Special Issue, we wish to express our gratitude to all colleagues who submitted manuscripts to this Special Issue and to the 51 reviewers for their time, attentive criticisms and constructive comments and suggestions. Our special thanks to Boriana Ovcharova, Managing Editor and the entire Editorial Office of *Nature Conservation* for their kind assistance and technical support.

References

Azzaro M, Packard TT, Monticelli LS, Maimone G, Rappazzo AC, Azzaro F, Grilli F, Crisafi E, La Ferla R (2019) Microbial metabolic rates in the Ross Sea: the ABIOCLEAR Project. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 441–475. https://doi.org/10.3897/natureconservation.34.30631

Balestrini R, Delconte CA, Buffagni A, Fumagalli A, Freppaz M, Buzzetti I, Calvo E (2019) Dynamic of nitrogen and dissolved organic carbon in an alpine forested catchment: atmospheric deposition and soil solution trends. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 41–66. https://doi.org/10.3897/natureconservation.34.30738

Cerino F, Fornasaro D, Kralj M, Giani M, Cabrini M (2019) Phytoplankton temporal dynamics in the coastal waters of the north-eastern Adriatic Sea (Mediterranean Sea) from 2010 to 2017. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 343–372. https://doi.org/10.3897/natureconservation.34.30720

Cerrato C, Rocchia E, Brunetti M, Bionda R, Bassano B, Provenzale A, Bonelli S, Viterbi R (2019) Butterfly distribution along altitudinal gradients: temporal changes over a short time period. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 91–118. https://doi.org/10.3897/natureconservation.34.30728

Chelli S, Simonetti E, Campetella G, Chiarucci A, Cervellini M, Tardella FM, Tomasella M, Canullo R (2019) Plant diversity changes in a nature reserve: a probabilistic sampling method for quantitative assessments. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 145–161. https://doi.org/10.3897/natureconservation.34.30043

Chiarini F, Ravaioli M, Capotondi L (2019) Interannual variability of vertical particle fluxes in the Ross Sea (Antarctica). In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 417–440. https://doi.org/10.3897/natureconservation.34.30732

Franzo A, Celussi M, Bazzaro M, Relitti F, Del Negro P (2019) Microbial processing of sedimentary organic matter at a shallow LTER site in the northern Adriatic Sea: an 8-year case study. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 397–415. https://doi.org/10.3897/natureconservation.34.30099

Freppaz M, Viglietti D, Balestrini R, Lonati M, Colombo N (2019) Climatic and pedoclimatic factors driving C and N dynamics in soil and surface water in the alpine tundra (NW-Italian Alps). In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 67–90. https://doi.org/10.3897/natureconservation.34.30737

Kröncke I, Neumann H, Dippner JW, Holbrook S, Lamy T, Miller R, Padedda BM, Pulina S, Reed DC, Reinikainen M, Satta CT, Sechi N, Soltwedel T, Suikkanen S, Lugliè A (2019) Comparison of biological and ecological long-term trends related to northern hemisphere climate in different marine ecosystems. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 311–341. https://doi.org/10.3897/natureconservation.34.30209

Marzialetti F, Bazzichetto M, Giulio S, Acosta ATR, Stanisci A, Malavasi M, Carranza ML (2019) Modelling *Acacia saligna* invasion on the Adriatic coastal landscape: An integrative approach using LTER data. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 127–144. https://doi.org/10.3897/natureconservation.34.29575

Monti-Birkenmeier M, Diociaiuti T, Umani SF (2019) Long-term changes in abundance and diversity of tintinnids in the Gulf of Trieste (Northern Adriatic Sea). In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 373–395. https://doi.org/10.3897/natureconservation.34.29841

Petriccione B, Bricca A (2019) Thirty years of ecological research at the Gran Sasso d'Italia LTER site: climate change in action. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 9–39. https://doi.org/10.3897/natureconservation.34.30218

Petrocelli A, Cecere E, Rubino F (2019) Successions of phytobenthos species in a Mediterranean transitional water system: the importance of long term observations. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 217–246. https://doi.org/10.3897/natureconservation.34.30055

Pitacco V, Mistri M, Infantini V, Sfriso A, Sfriso AA, Munari C (2019) Benthic studies in LTER sites: the use of taxonomy surrogates in the detection of long-term changes in lagoonal benthic assemblages. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 247–272. https://doi.org/10.3897/natureconservation.34.27610

Pulina S, Lugliè A, Mariani MA, Sarria M, Sechi N, Padedda BM (2019) Multiannual decrement of nutrient concentrations and phytoplankton cell size in a Mediterranean reservoir. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 163–191. https://doi.org/10.3897/natureconservation.34.30116

Ribera d'Alcalà M (2019) Similarities, differences and mechanisms of climate impact on terrestrial vs. marine ecosystems. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 505–523. https://doi.org/10.3897/natureconservation.34.30923

Sfriso A, Buosi A, Mistri M, Munari C, Franzoi P, Sfriso AA (2019) Long-term changes of the trophic status in transitional ecosystems of the northern Adriatic Sea, key parameters and future expectations: The lagoon of Venice as a study case. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 193–215. https://doi.org/10.3897/natureconservation.34.30473

Steinwandter M, Kahlen M, Tappeiner U, Seeber J (2019) First records of *Opetiopalpus sabulosus* Motschulsky, 1840 (Coleoptera, Cleridae) for the European Alps. In: Mazzocchi MG,

Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 119–125. https://doi.org/10.3897/natureconservation.34.30030

Zilioli M, Oggioni A, Tagliolato P, Pugnetti A, Carrara P (2019) Feeding Essential Biodiversity Variables (EBVs): actual and potential contributions from LTER-Italy. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 477–503. https://doi.org/10.3897/natureconservation.34.30735

Zingone A, D'Alelio D, Mazzocchi MG, Montresor M, Sarno D, LTER-MC team (2019) Time series and beyond: multifaceted plankton research at a marine Mediterranean LTER site. In: Mazzocchi MG, Capotondi L, Freppaz M, Lugliè A, Campanaro A (Eds) Italian Long-Term Ecological Research for understanding ecosystem diversity and functioning. Case studies from aquatic, terrestrial and transitional domains. Nature Conservation 34: 273–310. https://doi.org/10.3897/natureconservation.34.30789